(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 December 2003 (31.12.2003)

PCT

(10) International Publication Number
WO 2004/001896 A1

(51) International Patent Classification⁷: H01Q 1/24, 1/36, 11/08

(21) International Application Number: PCT/KR2002/001212

(22) International Filing Date: 25 June 2002 (25.06.2002)

(25) Filing Language: Korean

(26) Publication Language: English

(71) Applicant (*for all designated States except US*): E.M.W.ANTENNA CO., LTD. [KR/KR]; 137-1 Ojeon-dong, Uiwwang-si 437-819, Gyeonggi-do (KR).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): RYOU, Byung-Hoon [KR/KR]; 643-5 Kojan-dong, Ansan-si, Kyonggi-do 425-020 (KR). SUNG, Weon-Mo [KR/KR]; 560-14 sotca-dong, Dong-gu, Kwangju-city 501-220 (KR).

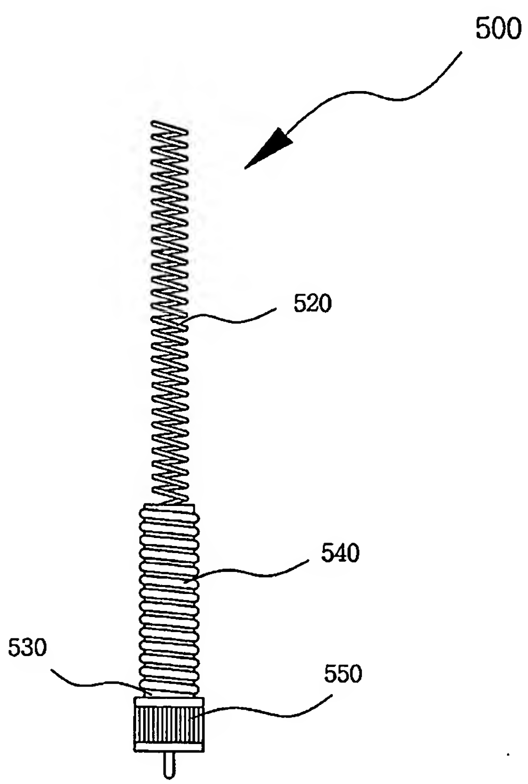
(74) Agents: KIM, Hee-So et al.; 2F, Daeho Building, 1502-12 Seocho 3-dong, Seocho-gu, Seoul 137-870 (KR).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: MULTIPLE BANDS TYPE ANTENNA AND METHOD FOR PRODUCING THE SAME



(57) Abstract: The present invention relates to a multiple band-type antenna and method of producing the same. In the present invention, a connecting part is disposed between a helical antenna element and a connector to have a space and form an impedance transformer, a dielectric element is formed to surround the lower portion of the helical antenna element and to be inserted into the upper portion of the helical antenna element, and an additional helical antenna element and a whip antenna are inserted into the dielectric element, so the antenna and method of the present invention can improve the efficiency of the antenna.

WO 2004/001896 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

10/518133
DT Rec'd PCT/PTO 14 DEC 2004
WO 2004/001896
13/PRTS
PCT/KR2002/001212

MULTIPLE BANDS TYPE ANTENNA AND METHOD FOR PRODUCING THE SAME

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to a multiple band-type antenna and method of producing the same, and more particularly to a multiple band-type antenna and method of producing the same, in which a connecting part is disposed between a helical antenna element and a connector to have a space and form an impedance transformer, a dielectric element is formed to surround the lower portion of the helical antenna element and to be inserted into the upper portion of the helical antenna element, and an additional helical antenna element and a whip antenna are inserted into the center portion of the dielectric element.

BACKGROUND OF THE INVENTION

In a general feeding structure of a conventional small-sized antenna used in wireless communications, a coaxial line is directly brought into contact with an antenna to perform feeding. For monopole antennas, a + part of a

coaxial line is brought into contact with an antenna to perform feeding. For dipole antennas, + and - parts of a coaxial line are brought into contact with an antenna to perform feeding.

These methods cause an unbalance condition between feeding lines of an antenna, so impedance matching becomes quite difficult. Additionally, a contact point between the antenna and the feeding line frequently varies, so the characteristics of the antenna are not constant, thus reducing the efficiency of the antenna.

As depicted in FIG. 1, U.S. Pat. No. 4,772,895 discloses an antenna 500 that broadens the frequency response. The antenna 500 includes a feed port 550 having a signal feed portion and a ground portion, a first helical antenna element 520 having opposed ends and exhibiting a first pitch and a second electrical length, one end of the first helical antenna element 520 being coupled to the signal feed portion of the feed port, and a second helical antenna element 540 having opposed ends and exhibiting a second pitch and a second electrical length.

The second helical antenna element 540 is

coaxially wound around a portion of the first helical antenna element 520, one end of the second helical antenna element 540 is coupled to the ground portion of the feed port 550, and the second pitch is equal to approximately 1/2 of the first pitch and the second electrical length is equal to approximately 1/3 of the first electrical length.

The antenna 500 is provided with a cylindrical spacer means 530 that is coaxially situated between the first and second helical antenna elements 520 and 540 to electrically insulate the first and second helical antenna elements 520 and 540. The spacer means 530 is sufficiently thin such that the first helical antenna element 520 is tightly coupled to the second helical antenna element 540 so as to broaden the frequency response exhibited by the first helical antenna element 520.

In the conventional antenna, the spacer means is situated between the first and second helical antenna elements, and is used to ground the antenna elements. The conventional antenna is problematic in that it cannot overcome the unbalance condition that is a problem in the conventional antenna, thus causing low efficiency, and

it is difficult to miniaturize.

With respect to the unbalance condition, helical antennas are chiefly classified into normal mode antennas and axial mode antennas. The case where the circularly shaped circumference of the helical antenna is considerably smaller than a wavelength corresponding to a working frequency falls under normal mode. Generally, helical antennas used in wireless communications devices have normal mode.

The characteristics of the normal mode helical antenna are that the characteristic impedance is considerably large and the radiation resistance value corresponding to actual radiation power is small. Accordingly, the input impedance value is considerably large in total and considerably different from the output impedance, 50 Ω, so the reflection loss is increased. This is the inherent unbalance condition of the conventional helical antenna that is used as a general wireless communications receiving antenna.

As illustrated in FIG. 2, U.S. Pat. No. 5,661,495 discloses an antenna device 200 having circuits 230 for transmitting and/or receiving radio signals as well as a

chassis 250 and a feeding point providing the electrical coupling of the antenna device to the communication equipment, which includes a hollow helical antenna 210 fixed externally on the chassis 250 and an antenna rod 220 slidable through the helical antenna 210, the helical antenna being coupled constantly via the feeding point to the circuits 230.

Meanwhile, the bandwidth of the helical antenna 210 is increased, a tuned ground surface is arranged near the feeding point, a direct Galvani electrical contact is not formed, and the ground surface is coupled to the protective earth of a communications device and can catch mirror current.

In the conventional antenna device, when the antenna rod is extended from a housing, the antenna rod and the helical antenna are coupled in parallel to the circuits 230. When the antenna rod 220 is retracted into the chassis 250, only the helical antenna is coupled to the circuits 230.

Meanwhile, a circuit equivalent to the case where a helical antenna is installed in a general cylindrical structure chiefly consists of a feeding part and the

parallel resonance parts of L and C. This conventional helical antenna reduces the length of the conventional monopole antenna but has the same resonant frequency as the conventional monopole antenna. In this case, the Q value is increased due to the parallel resonance of L and C, so a band of frequencies is narrowed.

Accordingly, with reference to a graph showing the electrical characteristics of a conventional helical antenna in Voltage Standing Wave Ratios (VSWRs) and a Smith Chart showing impedance measurement data, as shown in FIGs. 4a and 4b, as the VSWR value is increased and the impedance value is away from the center of the Smith Chart, the reflection loss of the antenna is increased and the bandwidth of the antenna is narrowed.

The bandwidths of the conventional antennas having structures shown in FIGs. 1 and 2 are each defined as a band of frequencies having a VSWR value equal to or less than 2. Accordingly, the conventional antennas each have a VSWR value ranging from 5 to 18 and the impedance value of the Smith Chart is considerably away from a value of 50 Ω situated at the center of the Smith Chart, so it can be

appreciated that the reflection loss value of the antenna increases and, therefore, the conventional antennas each have a relatively narrow band of frequencies.

Additionally, the conventional antenna is problematic in that the efficiency of the conventional antenna is deteriorated because the unbalance condition that is a problem in the conventional antenna is not overcome.

SUMMARY OF THE IVENTION

Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a multiple band-type antenna and method of producing the same, which can improve the efficiency of the antenna by overcoming an unbalance condition that is a problem in the conventional antenna, and can immediately cope with frequency variation resulting from various services because the antenna can accommodate various frequencies.

In order to accomplish the above object, the present invention provides a multiple band-type antenna, comprising a connecting element in which a disc is integrated with an

externally threaded connector, a fixing part having a space is formed on the disc, and a first helical antenna element is integrally formed on an end of the fixing part; a dielectric element disposed inside the first helical antenna element constituting part of the connecting element and formed to be hollow; and a covering material insert-molded outside the first helical antenna element.

In addition, the present invention provides a method of producing a multiple band-type antenna, comprising the 1st production step of forming a connector by threading a circumferential surface of a cylindrical metallic rod having a certain length and a certain diameter and forming a processed portion machined to be hollow above the connector; the 2nd production step of forming a fixing part having a space at a position where the connector and the processed portion are positioned near each other; the 3rd production step of forming a first helical antenna element by forming a helical shape from a position spaced apart from the space of the connecting part; the 4th production step of disposing a dielectric element arranged inside the first helical antenna element formed by the 3rd production step, formed to be

hollow, and leaked out of the fixing part having the space and the first helical antenna element to surround the fixing part; and the 5th production step of insert-molding a covering material outside the first helical antenna element.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 and 2 are sectional views showing the structures of conventional antennas;

FIG. 3 is a circuit equivalent to the structure in which a helical antenna element is mounted in a cylindrical structure;

FIG. 4a is a graph showing electrical characteristics measured in VSWRs in the case where a helical antenna element is mounted in a cylindrical fixing means, and FIG. 4b is a Smith Chart showing impedance measurement data in the case where the helical antenna element is mounted in the cylindrical fixing means;

FIG. 5a is a view showing a method of producing a multiple band-type antenna to which the technology of the present invention is applied, and FIG. 5b is a view showing another method of producing the multiple band-type

antenna;

FIG. 6 is a perspective view showing the structure of the antenna of the present invention;

FIG. 7 is a sectional view showing the connection of a fixing part and a dielectric element that is a principal part of the present antenna;

FIG. 8 is a circuit equivalent to the structure in which the fixing part is integrated with a first helical antenna element;

FIG. 9a is a graph showing the electrical characteristics of a structure, in which the fixing part and the first helical antenna element are integrated with each other, measured in VSWRs, and FIG. 9b is a Smith Chart showing impedance measurement data of the structure in which the fixing part and the first helical antenna element are integrated with each other;

FIGS. 10a to 10d are sectional views showing antennas in accordance with other embodiments of the present invention;

FIG. 11a is a graph showing electrical characteristics measured in VSWRs in the case where a second helical

antenna element is mounted in a structure in which a fixing part and a first helical antenna element are integrated with each other, and FIG. 12b is a Smith Chart showing impedance measurement data in the case where a second helical antenna element is mounted in a structure in which the fixing part and the first helical antenna element are integrated with each other; and

FIG. 12a is a graph showing electrical characteristics measured in VSWRs in the case where a third helical antenna element is mounted in a structure equipped with a second helical antenna element, and FIG. 12b is a Smith Chart showing impedance measurement data in the case where the third helical antenna element is mounted in a structure equipped with the second helical antenna element.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described in detail with reference to the attached drawings below.

FIG. 5a is a view showing a method of producing a multiple band-type antenna to which the technology of the

present invention is applied. Referring to this drawing, a connector 10 is formed by externally threading the circumferential surface of a cylindrical metallic rod having a certain length and a certain diameter and a workpiece is processed to have a hollow processed portion 12 above the connector 10 through the 1st production step S1. A connecting part 14 having a space 13 is formed at a position where the hollow processed portion 12 formed through the 1st production step S1 and the connector 10 are positioned near each other through the 2nd production step S2.

Meanwhile, a first helical antenna element 15 is formed to have a helical shape from a position spaced apart from the space 13 of the connecting part 14 through the 3rd production step S3. A dielectric element 20 is formed by being disposed inside the first helical antenna element formed by the 3rd production step, formed to be hollow, and leaked out of the connecting part 14 having the space 13 and the first helical antenna element 15 to surround the connecting part 14.

After the dielectric element 20 is formed, the production of the antenna is completed by the 5th

production step of insert-molding a covering material 30 out of the first helical antenna element 15.

As illustrated in FIG. 5b, in another method of the present invention, a connector 10 is formed by externally threading the circumferential surface of a cylindrical metallic rod having a certain length and a certain diameter and a workpiece is processed to have a hollow processed portion 12 above the connector 10 through the 1st production step S1. A first helical antenna element 15 is formed by fabricating the processed portion 12 to have a helical shape through the 3rd production step S3. Thereafter, a connecting part 14 having a space 13 is formed at a position near an end of the first helical antenna element 15 integrated with a disc 17.

A dielectric element 20 is formed by being disposed inside the first helical antenna element formed by the 3rd production step, formed to be hollow, and leaked out of the connecting part 14 having the space 13 and the first helical antenna element 15 to surround the connecting part 14.

After the dielectric element 20 is formed, the production of the antenna is completed by the 5th

production step of insert-molding a covering material 30 outside the first helical antenna element 15.

In the meantime, for other embodiments of the present invention, there can be employed a multiple band antenna producing method of disposing a second helical antenna element 40 inside a dielectric element 20 formed by a 3rd production step before insert-molding a covering material 30 as shown in FIG. 10a, and a multiple band antenna producing method of disposing a whip antenna 50 after insert-molding a covering material 30 as shown in FIG. 10b.

For other embodiments of the present invention, there can be employed a method of coating the outer surface of a second helical antenna element 40 arranged inside a first helical antenna element 15 with a dielectric element, and a method of arranging a second helical antenna element 40 and arranging a whip antenna 50 after insert-molding a covering material 30 as shown in FIG. 10c, or inserting a third helical antenna element 60 into one end of a whip antenna 50 as shown in FIG. 10d.

Additionally, the assembly time of the antenna may be reduced and the convenience of the production of the

antenna may be improved by changing the covering material 30 made by insert-molding to a cap structure.

The antenna fabricated by the above-described methods can improve the efficiency of the antenna by overcoming the unbalance condition that is a problem in the conventional antenna, and can immediately cope with the variation of a frequency resulting from various services because the antenna can accommodate various frequencies.

Meanwhile, in another method of the present invention, the sequence of the former method in which the 3rd production step S3 is performed after the 2nd production step S2 may be changed to a sequence in which the 2nd production step S2 is performed after the 3rd production step S3. The reason for this is that the sequence of production may be determined depending upon the convenience of production.

The structure of the multiple band-type antenna produced by the production method of the present invention is described below.

FIG. 6 is a perspective view showing the structure of the antenna to which the technology of the present

invention is applied. Referring to this drawing, in the multiple band-type antenna 1 to which the technology of the present invention is applied, a disk 17 is integrated with an externally threaded connector 10, a connecting part 14 provided with a space 13 is formed on the upper surface of the disc 17, a first helical antenna element 15 is integrally formed from the upper end of the connecting part 14, and a dielectric element 20 is installed to be inserted into the first helical antenna element 15 and formed to be hollow.

As shown in FIGs. 5 to 7, a dielectric element 20 is inserted into the first helical antenna element 15, formed to be hollow, and leaked between the connecting part 14 and the base of the first helical antenna element 15 to surround the connecting part 14, and a covering material 30 is insert-molded outside the first helical antenna element 15.

In the meantime, the reason why the dielectric element 20 is formed to leak to a position where the connecting part 14 and the first helical antenna element 15 begin and to surround the connecting part 14 is to prevent the material of the covering material 30 from entering and filling the

space 13 constituting the impedance transformer.

The operation and effect of the antenna having the above-described structure, for example, a single band as shown in FIGs. 5a and 5b, is that the externally threaded connector 10 is fixedly attached to the housing and the disk 17 prevents deflection.

In the meantime, when part of the cylindrical metallic rod is cut, the space 13 formed at the end of the connecting part and formed between the first helical antenna element 15 and the disc 17 becomes an impedance transformer.

Impedance varies depending upon the length of the first helical antenna element 15 and the bandwidth is generally determined by the structure, so the capacitive component of the helical antenna element has wide-band characteristics by the deformation of the feeding part in an early stage of impedance matching.

Actually, the increase of a series inductance effect has the same meaning as the decrease of a series capacitance effect occurring between the impedance transformer and the helical antenna that generally occurs in a helical antenna.

Accordingly, it can be appreciated that resonance is

generated in a space. Results according to the above-described structure are described below.

When the resonance circuit of the antenna generates parallel resonance, a Q value (the quality factor of a reactance element or resonance circuit having losses) considerably increases, so bandwidth thereof considerably decreases.

However, in the present invention, when the structure is converted into a distributed constant circuit and input impedance viewed at a feeding point is caused to generate series resonance, a desired bandwidth can be achieved over a relatively wide band of frequencies.

Meanwhile, the reason why parallel resonance, which is a general characteristic, is transformed to series resonance through the use of an impedance transformer is that the antenna is caused to have a pure resistance value by compensating for an inherent capacitance value of the helical antenna through the use of a structure.

In this case, the parallel resonance of C of the parallel resonance part and the impedance transformer and L of the helical antenna element is exhibited by

inserting the impedance transformer, which is equivalent to a parallel structure of a small R and a large C, between a feeding part and a parallel resonance part as shown in FIG. 8, so a frequency neighboring the center frequency of the dual resonance becomes the frequency of the serial resonance.

Accordingly, the frequency and the gain are all improved due to the resonance of the neighboring frequency. This means that the bandwidth is broadened by compensating for the increase of a Q value resulting from the L-C parallel resonance with serial resonance.

In the meantime, the series resonance frequency neighboring the center frequency can be flexibly adjusted because the C value of the impedance transformer in the equivalent circuit is adjusted according to the size of the space 13. The working bandwidth can be adjusted according to a required bandwidth regardless of the matching circuit, and can be adjusted by widening the area of the first helical antenna.

Meanwhile, in the antenna having a structure as shown in FIG. 5, a contact is formed below the structure by

inserting a whip antenna 50 into a first helical antenna 13 to penetrate the central portion thereof, which changes resonance characteristics, thus obtaining the desired frequency and gain.

The reason for changing resonance characteristics by inserting the whip antenna 50 into the fixed structure, which forms the space with the first helical antenna 15 inserted therein, is to cause the reduction of the Q value by affecting series resonance characteristics originating in the impedance transformer and parallel resonance characteristics originating in the helical element due to a coupling effect between the whip antenna 50 and the helical antenna because the whip antenna 50 and the helical antenna are simultaneously fed.

Gains are compared with one another depending upon the positions of the whip antenna electrically connected to the helical antenna as follows:

1. Comparison of gains depending upon frequencies when the whip antenna is extended from the helical antenna

Frequency (MHz)	Conventional antenna (dBm)	Present Antenna (dBm)	Gain comparison (dB)
822	-20.64	-19.86	+0.78
851	-21.17	-21.15	+0.02
867	-20.53	-20.37	+0.16
898	-20.87	-20.70	+0.170

2. Comparison of gains depending upon frequencies when the whip antenna is retracted into the helical antenna

Frequency (MHz)	Conventional antenna (dBm)	Present Antenna (dBm)	Gain comparison (dB)
822	-19.31	-19.22	+0.09
851	-20.53	-20.25	+0.28
867	-19.56	-19.32	+0.24
898	-19.93	-19.93	+0.00

Accordingly, the frequency band of the antenna may be extended by changing only a fixed structure but not the antenna and compensating for parallel resonance, which is the general characteristics of monopole and dipole antennas, with series resonance.

Actually, the increase of a series inductance effect

has the same meaning as the decrease of a series capacitance effect that is generated between the fixed structure and the helical antenna.

In the general antenna, as the working frequency band thereof is broadened, the gain thereof decreases, and as the working frequency band thereof is narrowed, the gain thereof increases. In contrast, the antenna of the present invention is significantly different from the conventional antenna in effect, in that as the frequency band thereof is broadened, the gain thereof increases, and as the frequency band is narrowed, the gain thereof decreases.

Meanwhile, FIG. 10a is a sectional view showing another structure of a multiple band-forming antenna according to the present invention, which is formed by disposing a second helical antenna element 40 inside a dielectric element 20 with one end thereof grounded onto a disc 17 and the other end made free. The reason why the lower portion of the dielectric element 20 preventing a covering material from entering and filling an inner space are projected outward is that a first helical antenna element 15 and the second helical antenna element 40 are positioned inside while

being prevented from coming into contact with each other.

In the meantime, an additional coating layer made of dielectric element may be formed around the second helical antenna element 30 disposed inside the first helical antenna element 15. In this case, the coating layer can reliably prevent the first and second helical antenna elements 15 and 30 from coming into contact with each other.

The operation and effect of an antenna in which a dual-band is formed by disposing a second helical antenna element 40 inside a first helical antenna element 15, as shown in FIG. 10b in accordance with an embodiment of the present invention, are that in the case where the VSWR is two or less, the antenna has a bandwidth of 230 MHz over a band of 800 to 900 MHz and a bandwidth of 250 MHz over a band of 1800 to 1900 MHz, as shown in FIGs 11a and 11b.

Meanwhile, as illustrated in FIG. 10c, in a structure where a second helical antenna element 40 is disposed inside the a first helical antenna element 15 and a whip antenna 50 is disposed to pass through the second helical antenna element 40, gains are compared with one another depending upon the positions of the whip antenna electrically

connected to the helical antenna as follows:

1. Comparison of gains depending upon frequencies when the whip antenna is extended from the helical antenna

Frequency (MHz)	Conventional antenna (dBm)	Present Antenna (dBm)	Gain comparison (dB)
890	-47.72	-46.58	+1.14
960	-47.69	-46.72	+0.97
1710	-52.37	-51.89	+0.48
1880	-53.17	-51.85	+1.32

2. Comparison of gains depending upon frequencies when the whip antenna is retracted into the helical antenna

Frequency (MHz)	Conventional antenna (dBm)	Present Antenna (dBm)	Gain comparison (dB)
890	-49.69	-49.15	+0.54
960	-50.52	-49.80	+0.72
1710	-54.69	-54.34	+0.35
1880	-56.72	-55.22	+1.5

Accordingly, it can be appreciated that the antenna

having a structure according to an embodiment of the present invention has an improved bandwidth compared with the case where only the first helical antenna element is disposed. The frequency band of the antenna may be extended by changing only a fixed structure but not the antenna and by compensating for parallel resonance, which is the general characteristics of monopole and dipole antennas, with series resonance.

The operation and effect of an antenna in which a triple-band is formed by disposing a whip antenna element 60 through the central portion of an insert-molded covering material 30 and positioning a third helical antenna element 60 in an upper portion of the whip antenna as shown in FIG. 10d in accordance with an embodiment of the present invention are that in the case where the VSWR is two or less, the antenna has a bandwidth of 140 MHz over a band of 800 MHz to 900 MHz and a bandwidth of 700 MHz over a band of 1800 to 1900 MHz and a band of 1885 to 2200 MHz as shown in FIGs 12a and 12b.

Meanwhile, gains are compared with one another depending upon the positions of the whip antenna

electrically connected to the helical antenna as follows:

1. Comparison of gains depending upon frequencies when the whip antenna is extended from the helical antenna

Frequency (MHz)	Conventional Antenna (dBm)	Present Antenna (dBm)	Gain comparison (dB)
824	-48.19	-47.47	+0.72
894	-47.98	-47.47	+0.51
1750	-53.21	-53.08	+0.13
1870	-53.22	-51.75	+1.47
1885	-59.69	-58.75	+1.25
2200	-59.42	-58.35	+1.07

2. Comparison of gains depending upon frequencies when the whip antenna is retracted into the helical antenna

Frequency (MHz)	Conventional Antenna (dBm)	Present Antenna (dBm)	Gain comparison (dB)
824	-50.65	-50.22	+0.43
894	-51.05	-50.39	+0.66
1750	-55.46	-55.04	+0.42
1870	-54.92	-53.62	+1.3

1885	-60.18	-59.01	+1.17
2200	-60.07	-59.09	+0.98

Accordingly, it can be appreciated that the antenna having a structure according to another embodiment of the present invention has an improved bandwidth compared with the general antenna forming a triple band, like antennas forming a single band and a dual band described above. The frequency band of the antenna may be extended by changing only a fixed structure but not the antenna and compensating for parallel resonance, which is the general characteristics of monopole and dipole antennas, with series resonance.

In the meantime, a single band and a dual band may be generated by adjusting the size and shape of a space using an antenna generating a triple band. The present invention converts parallel resonance into series resonance by changing the space of the structure, so a certain antenna generally and parallelly resonating at its center frequency obtains a working frequency range two to three times greater than the existing one and the gain thereof is improved.

In the multiple band- type antenna and method of

producing the same according to the present invention, a connecting part is disposed between a helical antenna element and a connector to have a space and form an impedance transformer, a dielectric element is formed to surround the lower portion of the helical antenna element and to be inserted into the upper portion of the helical antenna element, and an additional helical antenna element and a whip antenna are inserted into the dielectric element, so the antenna and method of the present invention can improve the efficiency of the antenna by overcoming the unbalance condition that is a problem in the conventional antenna and they can immediately cope with frequency variation resulting from various services because the antenna can accommodate various frequencies.

WHAT IS CLAIMED IS:

1. A method of producing a multiple band-type antenna, comprising:

the 1st production step of forming a connector by threading a circumferential surface of a cylindrical metallic rod having a certain length and a certain diameter and forming a processed portion machined to be hollow above the connector;

the 2nd production step of forming a fixing part having a space at a position where said connector and said processed portion are positioned near each other;

the 3rd production step of forming a first helical antenna element by forming a helical shape from a position spaced apart from said space of the connecting part;

the 4th production step of disposing a dielectric element arranged inside said first helical antenna element formed by said the 3rd production step, formed to be hollow, and leaked out of said fixing part having said space and said first helical antenna element to surround said fixing part; and

the 5th production step of insert-molding a covering

material outside said first helical antenna element.

2. The method of claim 1, wherein the sequence in which said the 3rd production step is performed after said the 2nd production step is replaced with a sequence in which said the 2nd production step is performed after said the 3rd production step.

3. The method of claim 1, further comprising the step of mounting a second helical antenna element inside said dielectric element formed by said the 4th production step before the insert-molding said covering material.

4. The method of claim 3, further comprising the step of inserting a whip antenna into said covering material after installing said second helical antenna element and insert-molding said covering material.

5. The method of claim 3, wherein said second helical antenna element disposed inside said first helical antenna element is coated on an external surface thereof with

a dielectric coating material.

6. The method of claim 1, further comprising the step of arranging a whip antenna in a structure obtained after insert-molding said covering material.

7. The method of claim 6, further comprising a helical antenna element arranged in one end of said whip antenna.

8. The method of claim 1, wherein said covering material formed by said insert-molding is fabricated in a cap form.

9. The method of claim 1, wherein a working band of frequencies is adjusted by adjusting a size of said space.

10. A multiple band-type antenna, comprising:

a connecting element in which a disc is integrated with an externally threaded connector, a fixing part having a space is formed on said disc, and a first helical antenna element is integrally formed on an end of said fixing

part;

a dielectric element disposed inside said first helical antenna element constituting part of said connecting element and formed to be hollow; and

a covering material insert-molded outside said first helical antenna element.

11. The multiple band-type antenna of claim 10, further comprising a second helical antenna element disposed inside said dielectric element with a first end thereof grounded to said disc and a second end made free.

12. The multiple band-type antenna of claim 11, further comprising a whip antenna disposed to penetrate into a center of said covering material after said second helical antenna element is arranged and said covering material is insert-molded.

13. The multiple band-type antenna of claim 10, further comprising a whip antenna disposed to penetrate into a center of said covering material after said covering

material is insert-molded.

14. The multiple band-type antenna of claim 12, further comprising a third helical antenna element arranged in one end of said whip antenna.

15. The multiple band-type antenna of claim 10, wherein said second helical antenna element disposed inside said first helical antenna element is coated on an external surface there with a dielectric coating material

16. The multiple band-type antenna of claim 10, wherein said first helical antenna has a plate-shaped section.

FIG. 1

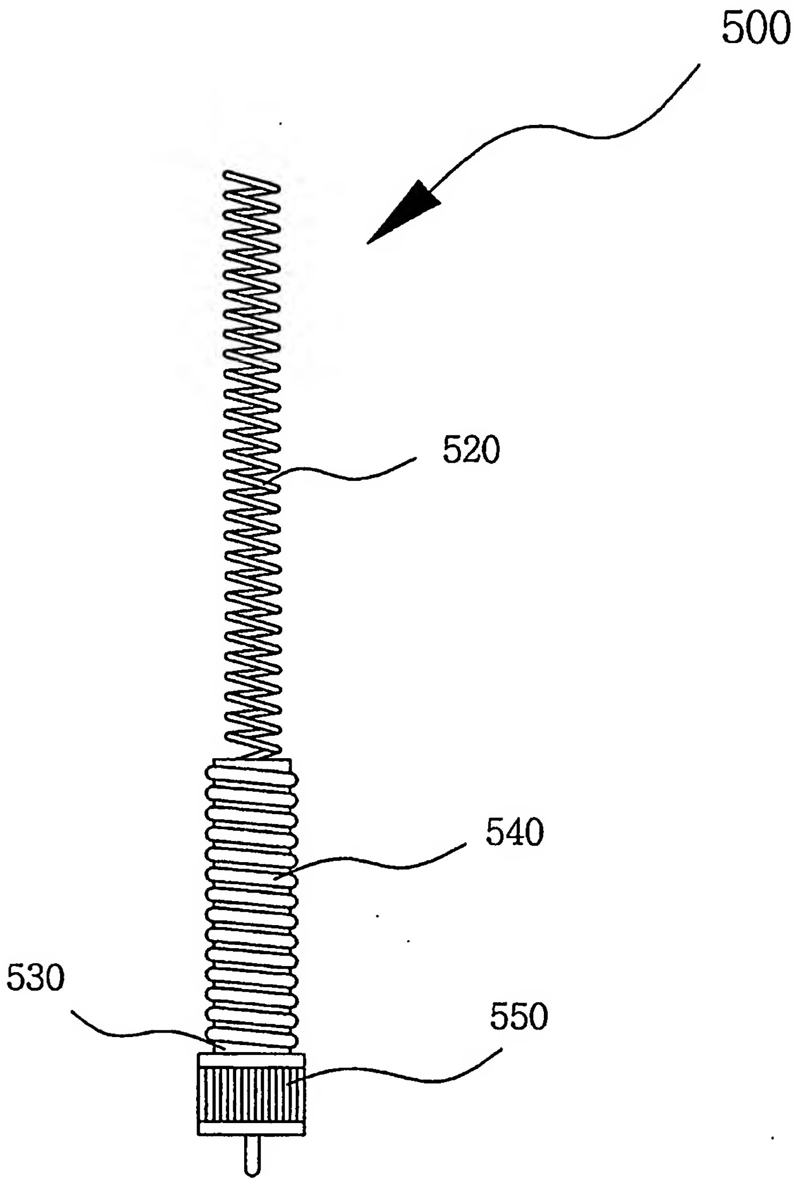


FIG. 2

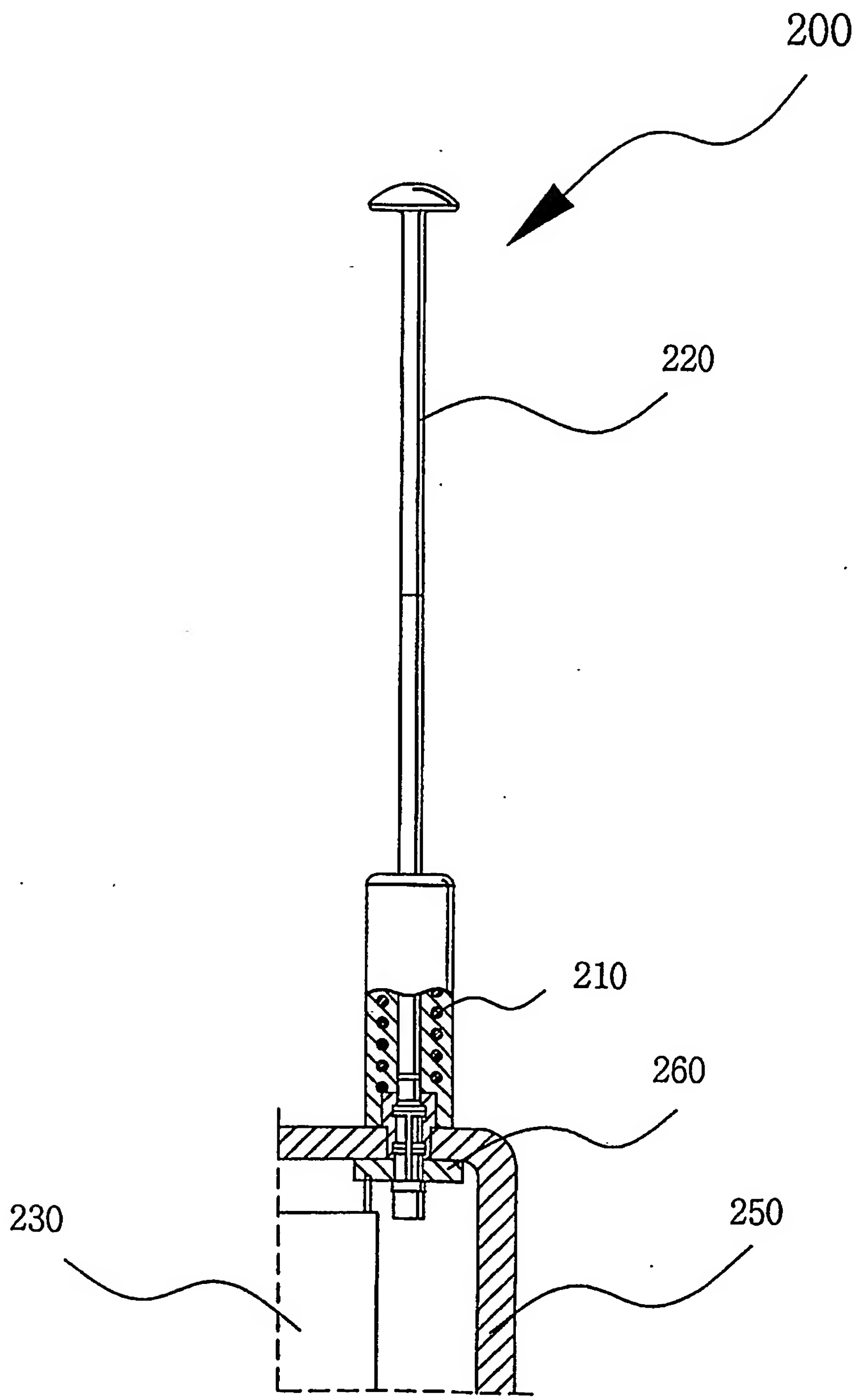


FIG. 3

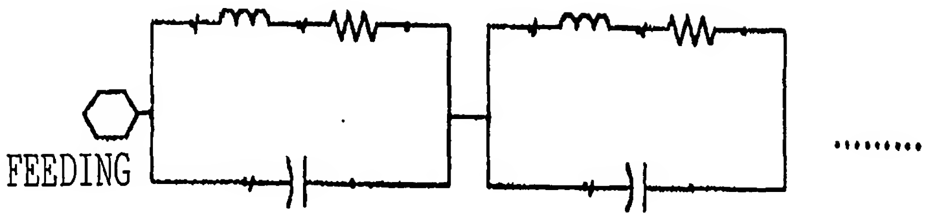

FEEDING

FIG. 4a

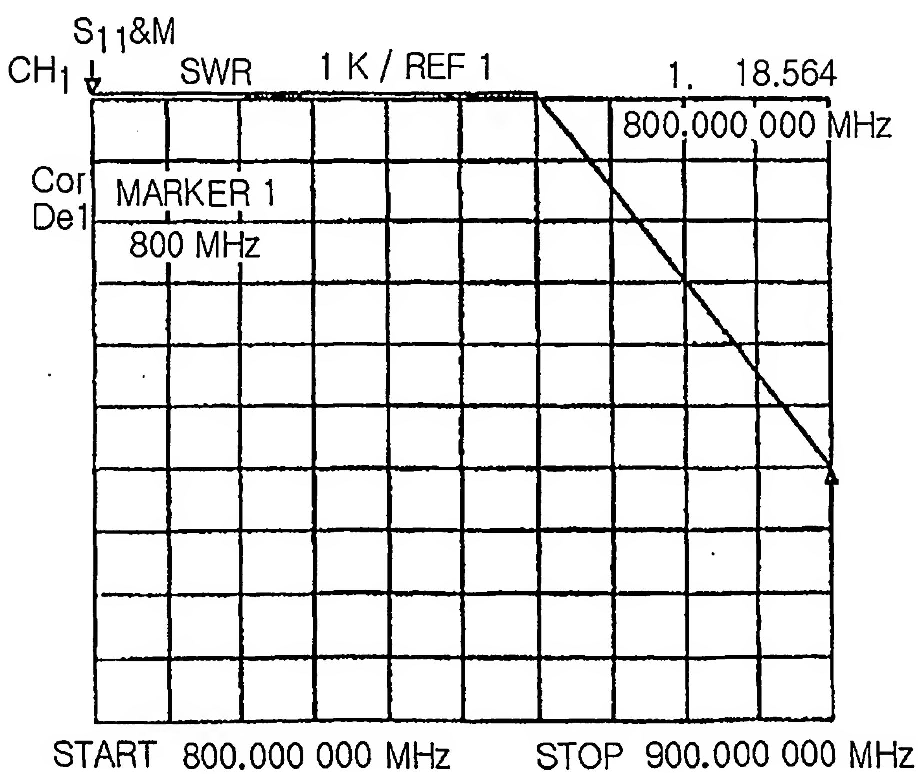

S11&M
CH1
SWR
1 K / REF 1
1. 18.564
800.000 000 MHz
Cor
Del
MARKER 1
800 MHz
START 800.000 000 MHz
STOP 900.000 000 MHz

FIG. 4b

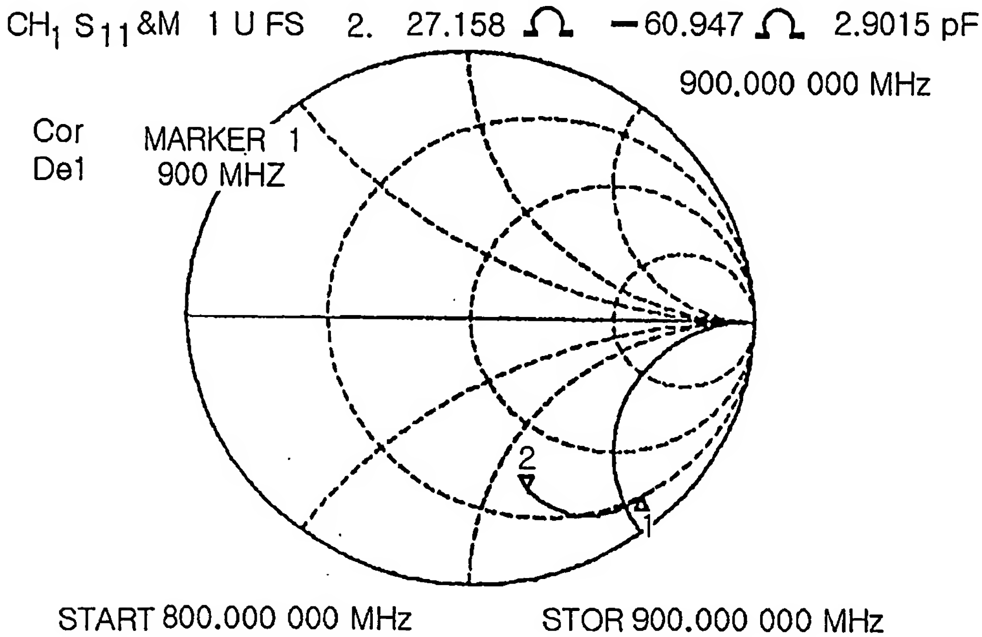

CH1 S11 &M 1 U FS 2. 27.158 Ω −60.947 Ω 2.9015 pF
900.000 000 MHz
Cor
De1
MARKER 1
900 MHZ
2
1
START 800.000 000 MHz
STOR 900.000 000 MHz

FIG. 5a

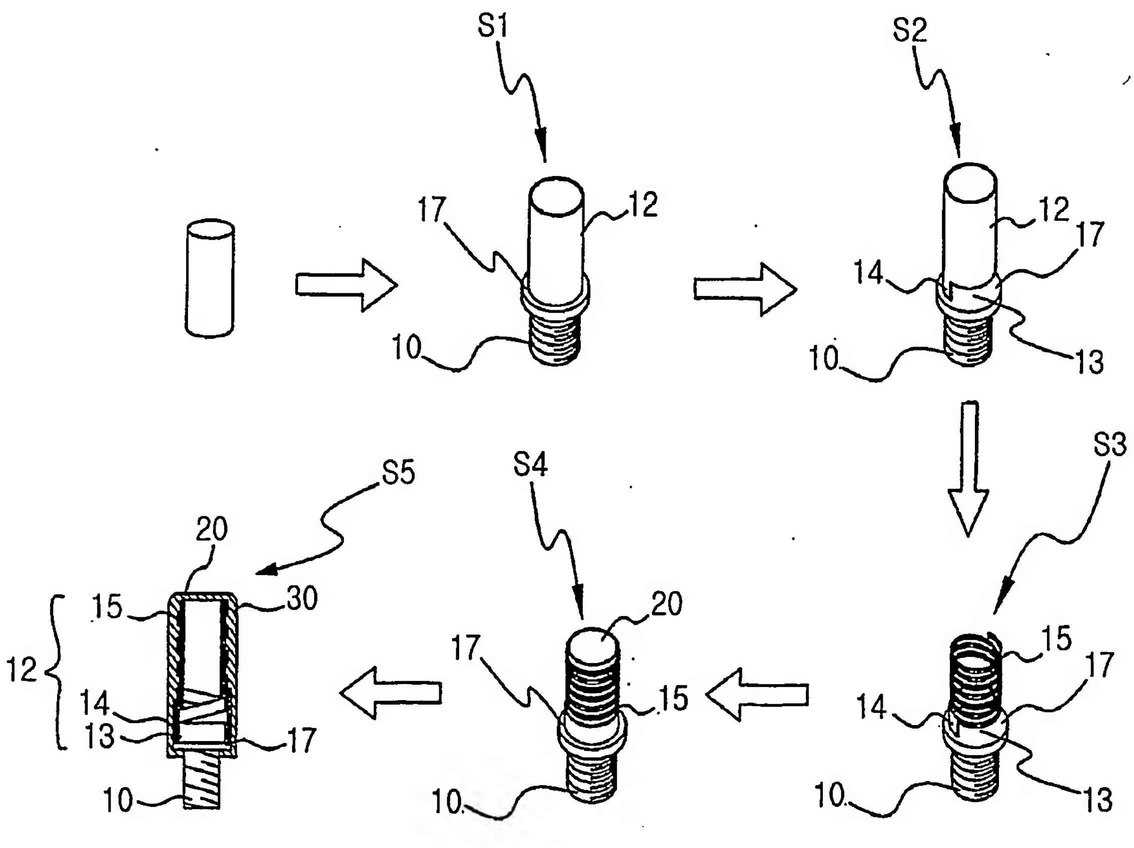

S1
S2
S3
S4
S5
10
12
13
14
15
17
20
30

FIG. 5b

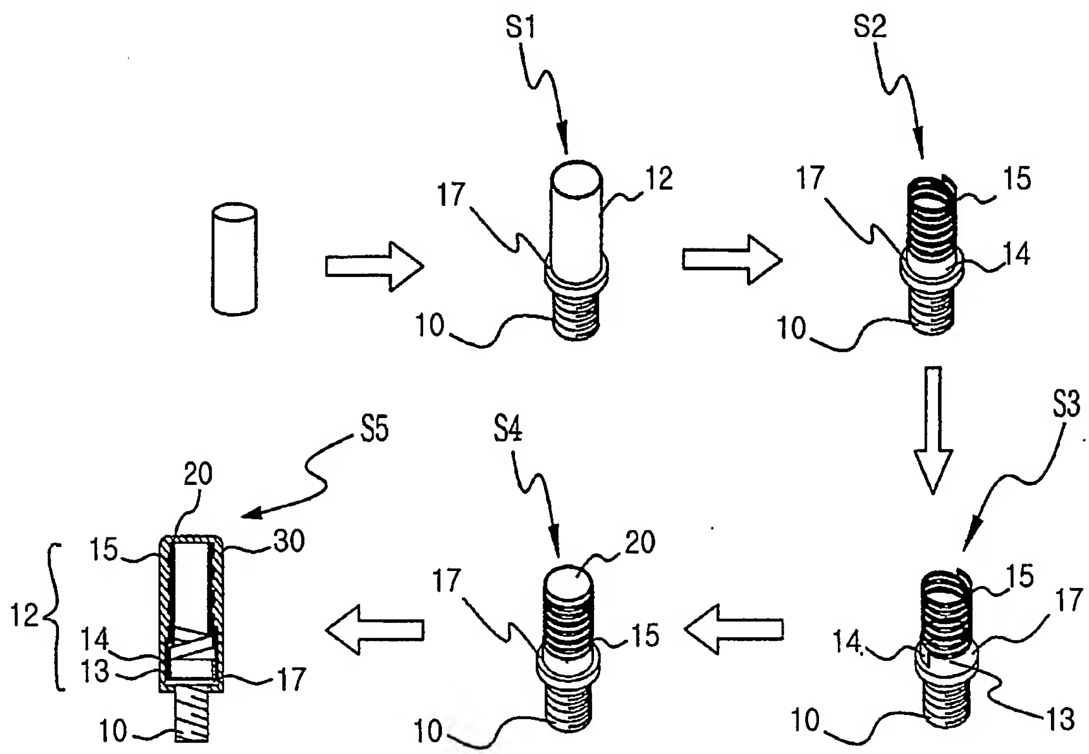


FIG. 6

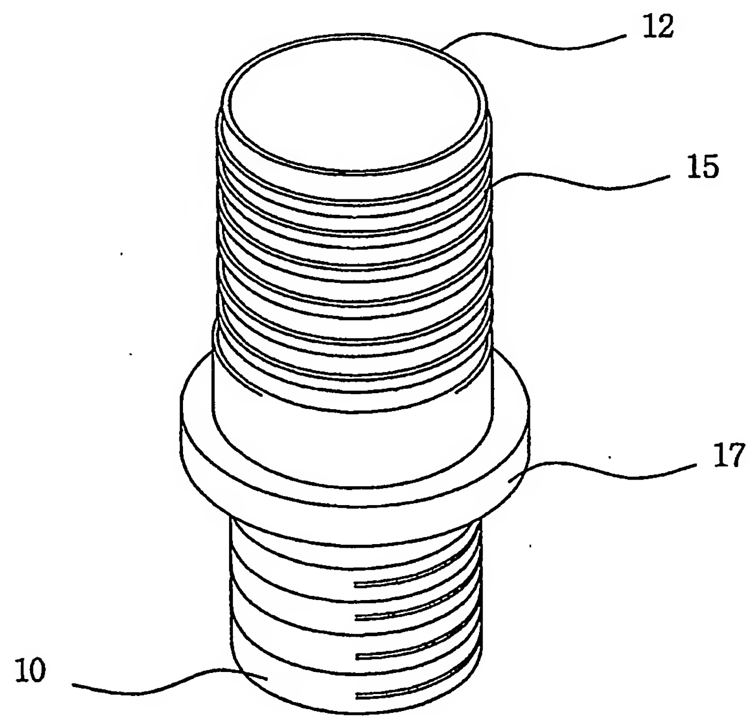


FIG. 7

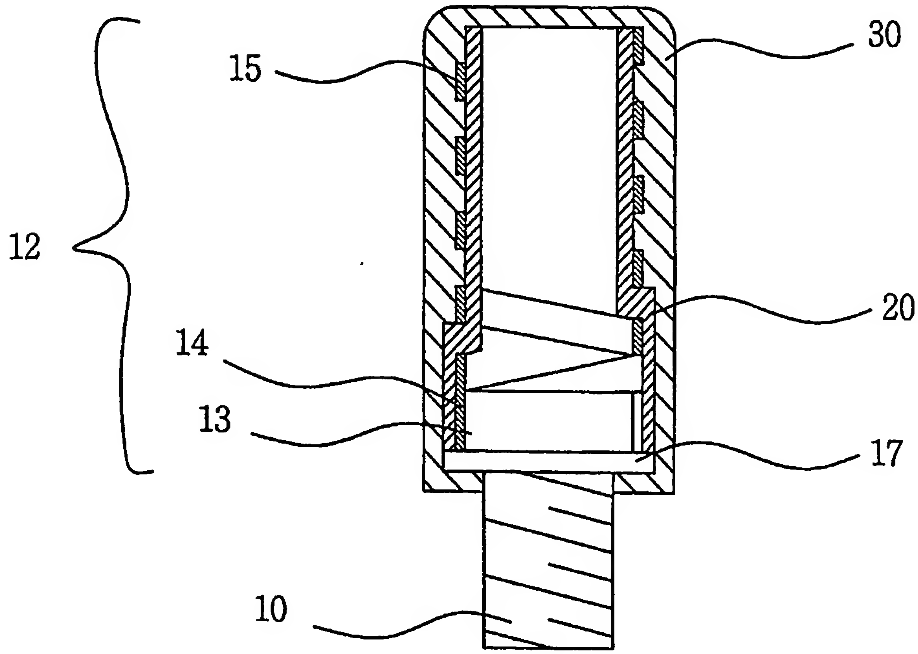

30
15
12
20
14
13
17
10

FIG. 8

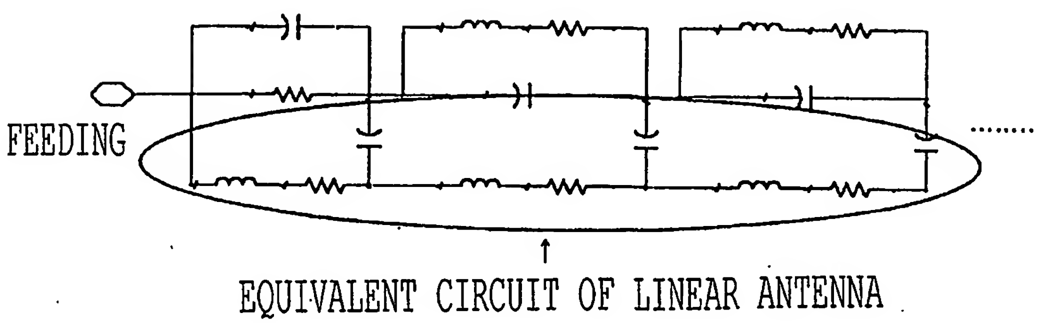

FEEDING
....
EQUIVALENT CIRCUIT OF LINEAR ANTENNA

FIG. 9a

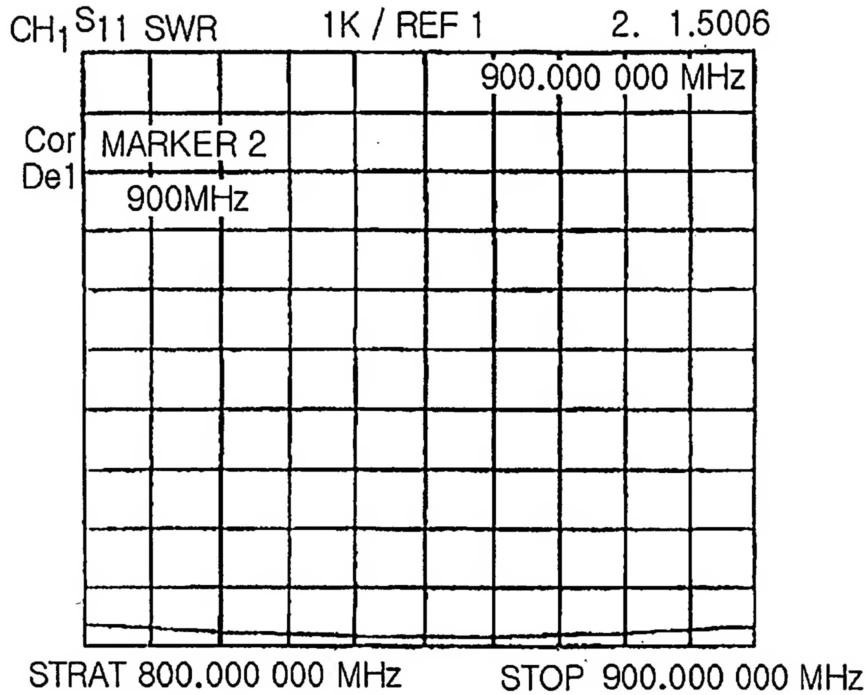

CH1 S11 SWR 1K / REF 1 2. 1.5006
900.000 000 MHz
Cor
De1
MARKER 2
900MHz
STRAT 800.000 000 MHz
STOP 900.000 000 MHz

FIG. 9b

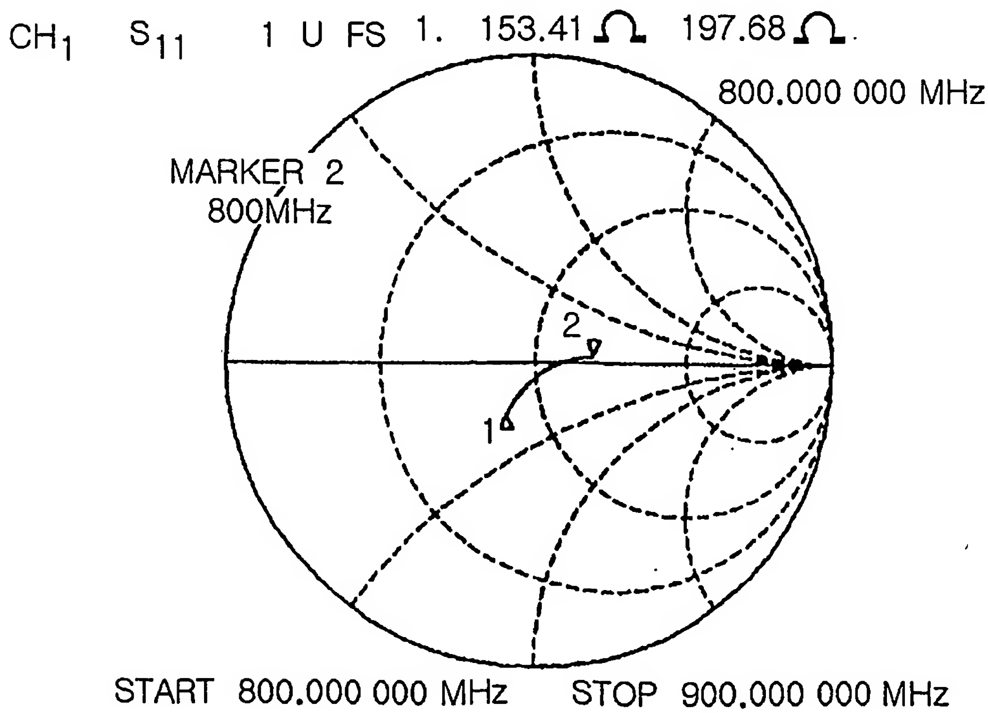

CH1 S11 1 U FS 1. 153.41 Ω 197.68 Ω
800.000 000 MHz
MARKER 2
800MHz
2
1
START 800.000 000 MHz
STOP 900.000 000 MHz

FIG. 10a

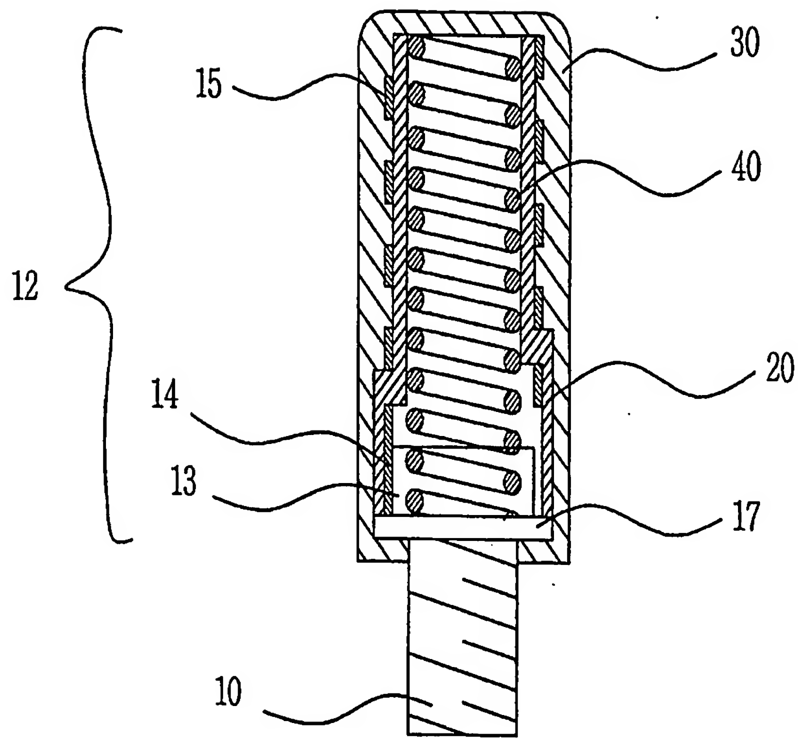


FIG. 10b

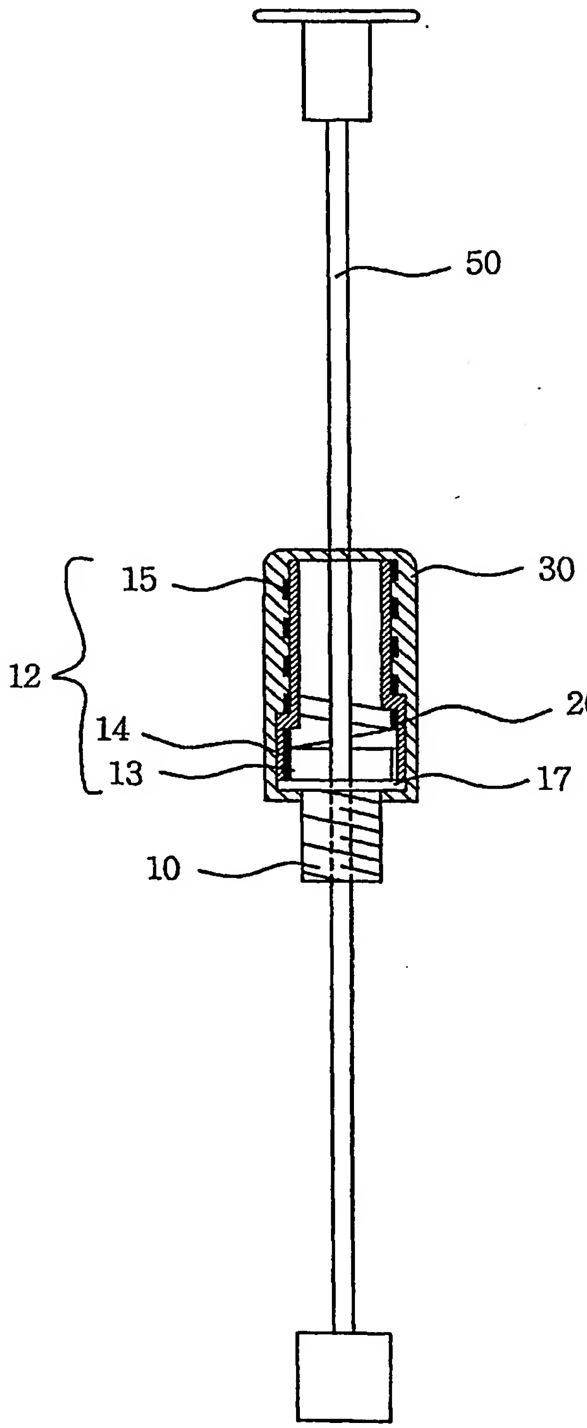


FIG. 10c

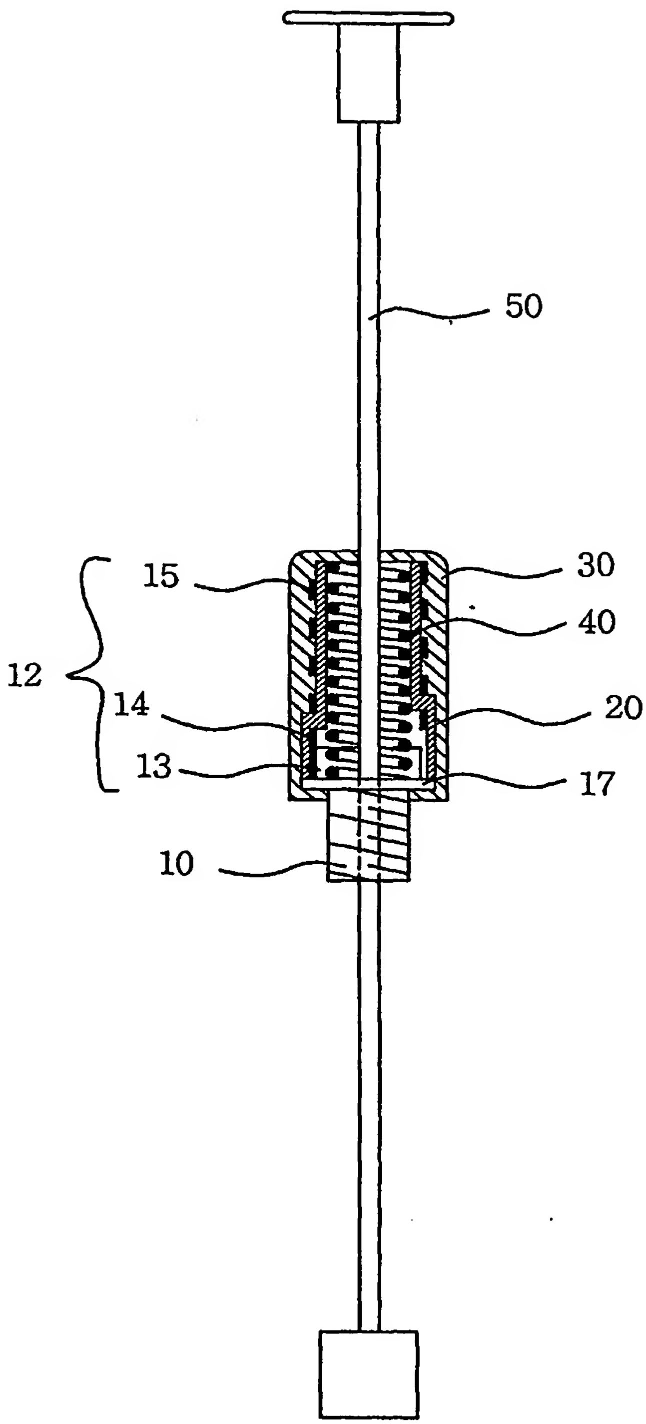


FIG. 10d

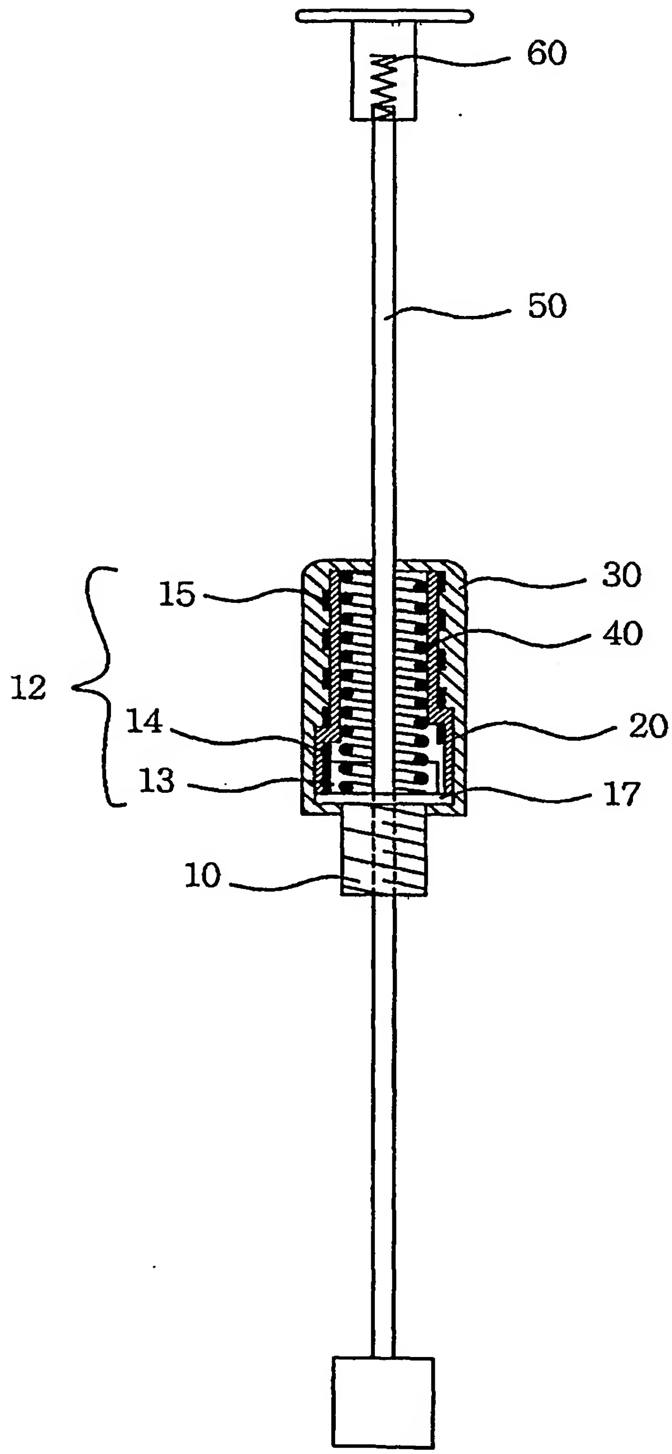


FIG. 11a

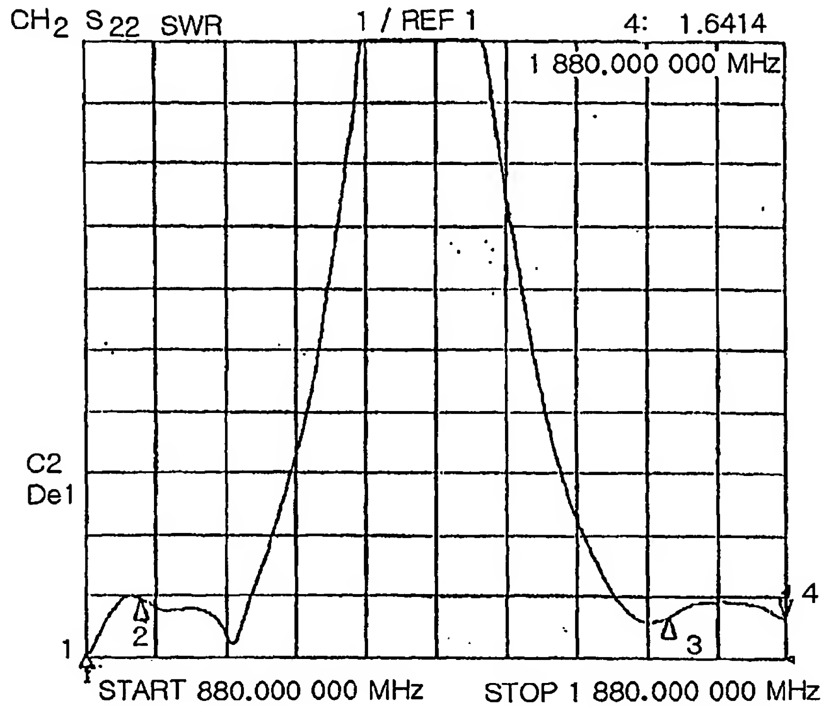


FIG. 11b

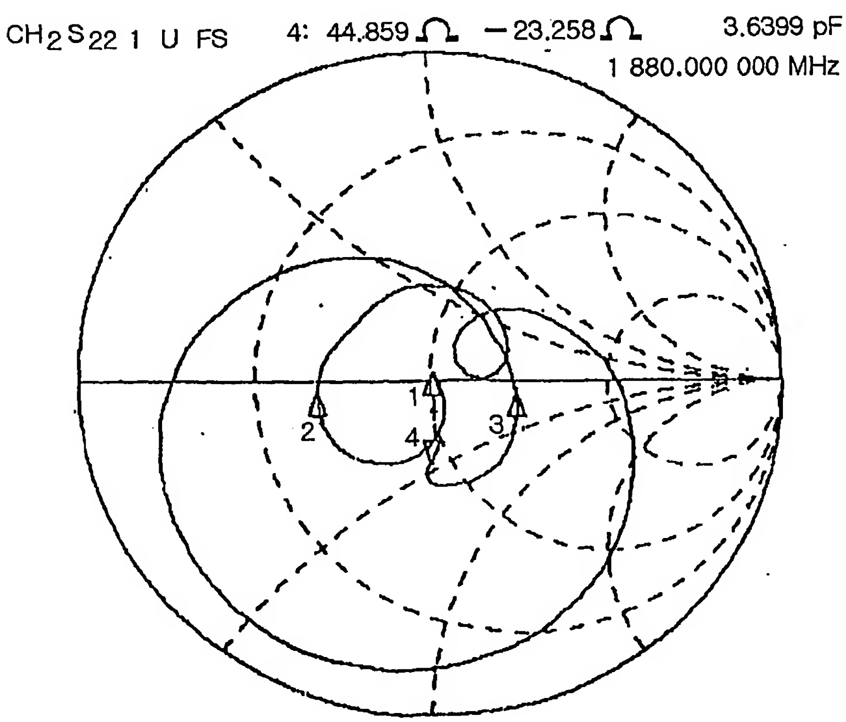


FIG. 12a

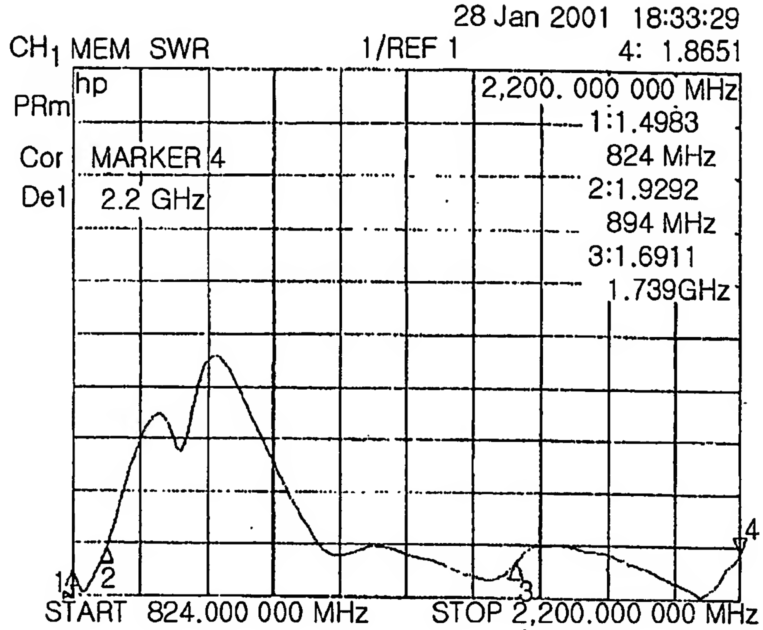


FIG. 12b